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Derivation of canonical total-sequences triggering landslides and floodings in complex terrain of the European Alps

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Floodings and landslides are amongst the most devastating damage-processes worldwide. Associated risk levels are particularly high in topographically complex terrain. Along with the increase in climate-change induced extreme-events, research devoted to the identification of so-called Climate Indices (CIs) describing weather phenomena triggering hazard-occurrences and intensities gain rising emphasis.

In this study we accomplish the first-time unification of the three most comprehensive cadastres on weather-induced hazard-processes, compiled and maintained by federal authorities. The therefrom resulting ‘event space’ stretches seven decades from 1950 onwards and contains 20.000 hazard occurrences, classified into six different process-categories. Event data are analyzed together with a high-quality, daily-based dataset providing temperatures and precipitation totals on a 1 km grid across the Austrian part of the European Alps.

On the resulting unprecedented extent of extreme-weather triggered hazard-processes and gridded weather observations, we are able to examine the hypothesis that daily sequences of precipitation-totals preceding damage-events allow for detecting temporal weather-sequences uniquely allocatable to various hazard-categories in three orographically distinct regions in the European Alps. We pursue this research aim by analyzing for each hazard-category its quadratic form representing the physics contained in the observations. Resulting eigen-directions, invariant under its inherent second order tensor, are the sought-for total-sequences (CIs) and hence reject the alternative hypothesis. Therefore, precipitation total-sequences can be uniquely assigned to every hazard category within each region, giving an overall of 18 CIs.

It is important to note that findings based on this novel, objective approach do not contradict, but rather add to attained research achievements by introducing this new perspective on the subject. Obtained CIs have substantial potential in research and applications. In civil defense, safeguarding critical infrastructure, early warning systems and the development of sustainable protection strategies, findings are in implementation by responsible decision-makers and in intense discussion with the European Freight Leaders Forum.